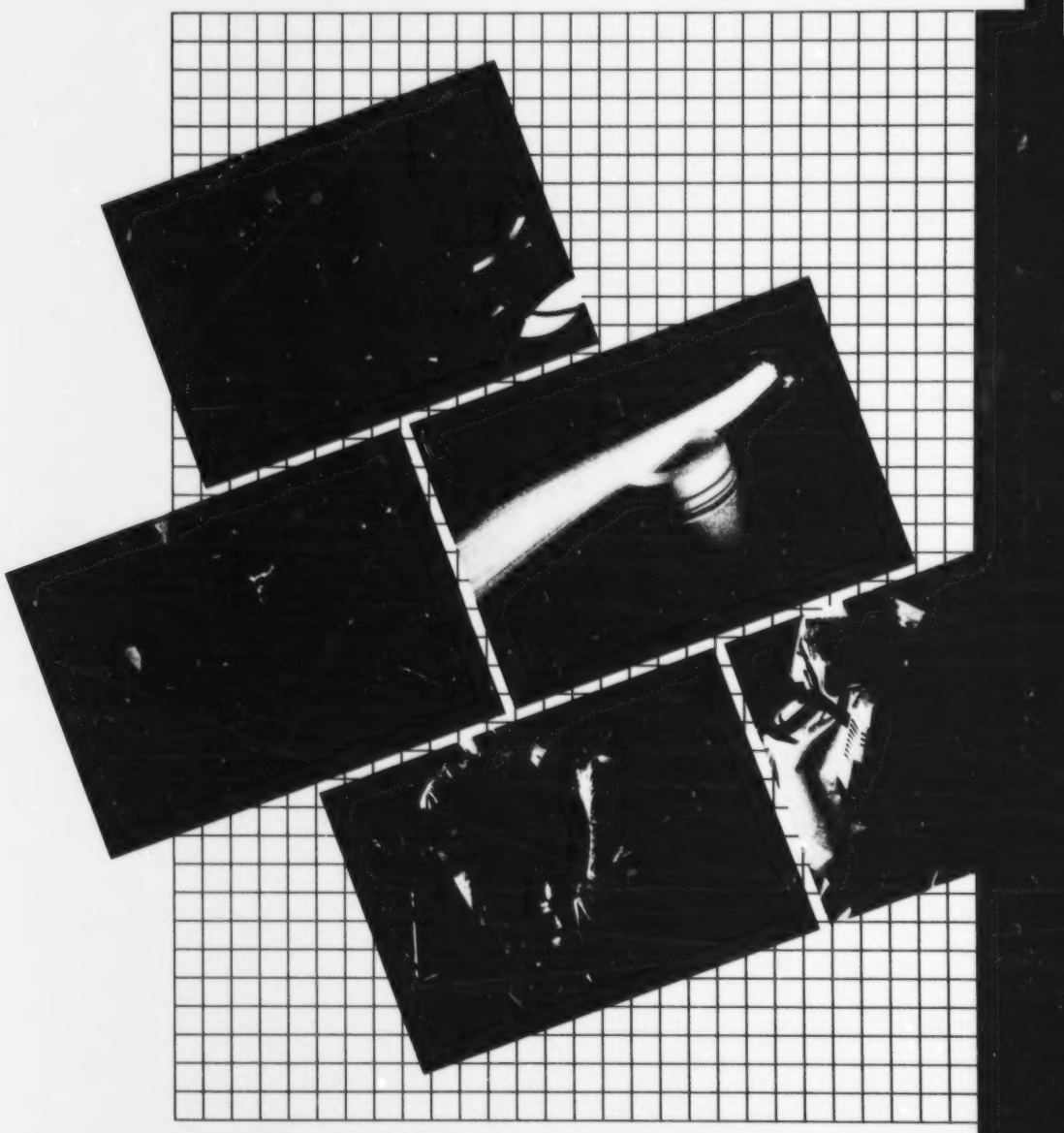
Ontario Research Foundation



Annual Report 1985

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Highlights

We conducted a study to establish criteria for airline passenger smoke masks.

Production of materials in space is undergoing early investigation at ORF.

Our new Mobile Source Monitoring Lab was employed on two energy-from-waste projects in the U.S.

Porous metal coated heart valves are being examined for Shiley Inc.

Howden Canada constructed a 1000 Kw Plasma Extended Arc Reactor in our Pilot Plant.

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A note from the Chairman

Despite difficulties, 1985 ended as a satisfactory year for ORF, one during which, I am gratified to say, we achieved the more important objectives of the first year of our five-year plan for growth and expansion. Our president, Paul Midghall, his officers and his team are all to be congratulated and I look forward to the outcome of 1986 with optimism.

Today the needs and opportunities for ORF's services have never been greater. International competition against Canadian industries continues to grow, driven by the application of new and improved technology, not only in established industrial countries, but also in newly developed and emerging countries in which cost structures can be extremely competitive.

"Advanced technology", "entrepreneurial ability" and like terms are perhaps overused at the present time but these are nevertheless the attributes we of Ontario and of Canada must acquire if we are to maintain, let alone improve, our economic and social position in this world. Whatever the outcome of the Federal government's efforts to establish "freer trade" with the U.S.A., or the efforts of hard pressed industries to gain additional protection—the prime necessity will remain the same—to improve substantially our competitive industrial capability.

Our basic resource industries, for long a key factor in the Canadian economy, must be revitalized by an infusion of technological innovation. Our secondary and tertiary industries must modernize their materials and processes, must grow in size and diversity and to the extent possible, establish technological self-sufficiency. The necessary technology to achieve all of this has already been developed and is available—it remains to apply it effectively and urgently in Canada.

Just one qualifying comment—improvements in technology are essential, but these alone will not suffice; there must be parallel profound adjustments in our financial, social and cultural attitudes, changes that clearly will be immensely more difficult to effect.

Unfortunately, in these social and cultural aspects of the problem, ORF can be of little direct help, but its role in the introduction of new and improved technology is clear. ORF must strive with increasing intensity to anticipate the technical needs of its clients, collect and analyse the relevant available technology and then adapt and make available to those clients the most appropriate technology in an assimilative form. This effort must be directed not only at existing industrial sectors, but more importantly at the establishment of new sectors based on recent scientific developments of industrial potential.

Those components of the Canadian industrial complex most likely to gain from ORF's activities are the small and medium sized companies—those which have limited in-house technical capability. Such companies must seek outside help. So must, however, governmental departments and large corporations when they face the need to cope with technology outside their available areas of expertise. Indeed major companies and the provincial and federal governments have been, and will probably continue to be, a major source of ORF's income.

ORF must continue to cover a wide spectrum of technologies, but certain of these must be selected for major thrusts in the immediate future. Clearly, the establishment of an efficient system for the collection, analysis and dissemination of up-to-date information on technical developments of likely industrial impact in Canada is a basic requirement. Another topic for immediate attention is that of the many newly developed advanced materials—some of which clearly threaten to replace the traditional materials so important to Canada's mineral resource industry. Other areas for concentrated action will no doubt emerge; the range of possibilities is wide. It is important that ORF retain adequate flexibility to cope with those that do.

We live in an exciting time. It is my fortune to be actively associated with ORF, an organization close to the cutting edge and with the ability and the potential to exert a real influence on our economy.

W. Steven

Comments from the President

A year ago in my comments I reiterated ORF's great concern about the accelerating pace of technological change throughout the world, not only among the established industrial nations but also among the newly industrialized countries of the Third World. Since that time, my colleagues and I have studied extensively the relevant activities in two countries which can be numbered among the technological giants—West Germany and Japan. As a result, I am more than ever convinced that we are living in a world of tough, uncompromising and aggressive technological competition. Whether we like it or not, technological know-how is the new driving force in the global economy, and any nation, large or small—any business, large or small—that fails to take advantage of the sources of this new knowledge, or fails to apply it, will be an also-ran in the supercharged competitive race.

Technological know-how is the new driving force in the global economy.

The need to compete aggressively shouldn't faze Canadians; we're an energetic, ingenious and motivated people. But if, in the immediate future, we are going to play successfully in the international game, we must be sure that Canadian enterprises have access to advanced technology—access that's available to, and affordable by, small and medium-sized businesses as well as the strongly financed corporate giants.

This access, in my view, constitutes the real *raison d'être* of organizations like the Ontario Research Foundation—to provide a source of reliable consultation and assistance, a state-of-the-art facility for doing the kind of practical, results-directed technology development that's necessary for Canadian firms to achieve competitive excellence . . . or in some cases to survive.

A First Step Towards Achieving a Five-Year Goal

In 1985, we achieved our year-one financial goal in a five-year strategic plan with the ambitious objective of doubling our business. We made substantive increases both in revenues and in technology diffusion to clients. During the next year or two we will be continuing our emphasis on such areas as advanced industrial materials and advanced technical information.

At the same time we are continuing to search out areas for investment such as laser technology and specific fields of computer aided engineering. We are investing in these areas because we are determined to be in the forefront of contemporary development and because we want this kind of sophistication to be readily available through ORF to all Canadian industries who need it, regardless of size.

We intend our five-year plan to succeed. If ORF can double its size we can bring in more people and be an even more significant force in expanding the market for skilled jobs in Ontario.

Performance Indicators: 1984-85

		1985 Increase
Canadian Industrial Revenue	$10,054,000	13.5%
No. of Individual Clients	2,100	4%
No. of Business Visitors	9,820	34%

Satisfying Financial Performance

In 1985 we achieved an increase in revenue from work done for Canadian industry that amounted to more than thirteen percent over the previous year. The number of business visitors to our premises increased by more than one-third—each visit resulting in the transfer of some technology from our laboratories to our clients' workplaces.

In the longer term—over the past ten-year period—the number of our clients has risen from 1,271 to 2,100 and the number of technologies in which we offer services more than doubled.

Although we got off to a slow start and needed to postpone a few long range projects, I think we can look back on our performance in 1985 with satisfaction, tempered by realism.

We are a technical facility working with state-of-the-art equipment, but we try never to forget that our most valuable asset remains our *people*; I was very impressed and thankful for the sometimes valiant efforts of our employees during the year. Our staff must not only be men and women of exceptional talent in their diverse disciplines, they must also be capable of dedicated teamwork. Moreover, they must have an appreciation for the very demanding results expected of ORF in this world of exploding technology . . . not only to personally keep up-to-date, but to effectively transfer this new knowledge to our large number of clients.

In turn, the job of management must be to ensure that every member of our staff has every possible opportunity for skill development and career growth.

Once again, we wish to express our appreciation to the Government of Ontario for their financial grant which enables us to finance newer areas of technological growth to meet the demands of client service.

One of my personal highlights in 1985 was working closely with a more active Board of Governors and Executive Committee of the Board. Their help and support was truly commendable. We will all miss the contributions made by Mr. Alton Cartwright, former Chairman of the Board of Canadian General Electric, who resigned from our Board when he moved to Florida.

A unique opportunity to share in practical scientific knowledge.

I am more and more convinced that the Ontario Research Foundation provides a unique opportunity for Canadian companies of all types and sizes to share in the proliferation of practical scientific knowledge—and the direct application of that knowledge to the materials they use and the processes they employ—without facing the massive capital expenditures involved in in-house research. I again urge those forward-looking business people, who share a realization of technology's place in the world of tomorrow, to keep an unswerving focus on the imperatives of global competition.

W. Paul Midghall

W. Paul Midghall

Materials

The growing sophistication of materials technology and, in many cases, the need for totally new materials to meet the demands of global competition, has added significance to ORF's work in this highly specialized area of research—even to the extent of examining prospects for the creation of new materials in the zero gravity of outer space.

Seeking new and unique materials properties

ORF cooperated with the Department of National Defence in the area of engineering ceramics in a major effort to develop ceramic coating/monolithics for diesel engine application. A single-cylinder research engine was selected for these studies, set up on a test bed, and baseline operating data were collected on the standard engine. This information will permit accurate comparison with the engine when fitted with ceramic components. It will then be tested for multi-fuel capability. We also undertook a related program on behalf of the Defence Research Establishment Atlantic (DREA) to evaluate wear properties of ceramics for the diesel engine.

For the Defence Research Establishment Valcartier (DREV), ORF has been engaged to develop reinforcing fibres to increase the fracture resistance of gun propellants. Equipment for the manufacture of these fibres was designed and constructed by ORF and sample quantities of the fibres prepared.

Space experiments have demonstrated the possibilities of producing totally unique materials in low-gravity environments. Gallium arsenide is recognized as being a potentially significant material for communications technology and there are substantial benefits in this compound being produced in space; however, before space production can be considered, the most efficient method of production here on earth must be determined. On behalf of T.A. Croil Associates, ORF undertook a review of methods for the production of

A ceramic coated piston is installed in a single cylinder research engine for evaluation in our Centre for Alternative Fuel Utilization (CAFU).

single-crystal gallium arsenide. Our research has led to a proposal being made to the Federal Government by a consortium comprising T.A. Croil Associates, Honeywell Canada and Noranda, for an investigation of the feasibility of carrying out organometallic chemical vapour deposition of gallium arsenide in space.

Controlling fire and flammability

ORF was engaged by Celanese Canada Inc. to investigate the safety aspects of alcohol based automotive fuels with respect to flammability, explosion hazards and fire fighting. Celanese received support from Transport Canada for this work. The study determined that there were no major safety barriers with respect to use of the fuels, but a number of concerns were identified related to flame visibility and fuel ignition hazards in high level alcohol blends which required clarification with further study.

Our Fire and Flammability Centre has been under contract to Consumer & Corporate Affairs Canada for several years as a result of statistics that show about 4,000 fires per year originating in upholstered furniture—the majority caused by smouldering cigarettes. We have been conducting a study relating to the combustion characteristics of upholstered furniture for the purpose of assessing the cigarette-ignitability of various combinations of cover fabrics and filling materials used currently in furniture upholstery.

Glass and ceramics technology

Two programs undertaken on behalf of the Energy Division of the National Research Council involved infrared reflective coatings and silica gel. The successful completion of these programs resulted in products being developed with important industrial applications.

For Applied Physics Specialties of Toronto, ORF initiated an Industrial Research Assistance Program (IRAP) to develop anti-reflective films using sol-gel.

Eric Simmons controls a burner used to test airline seat materials against new government regulations for flammability.

Major programs for BM Hi-Tech were completed in 1985 in the area of electronic ceramics, involving research into piezoceramics and piezoceramic-polymer composites.

The Thermal Insulation Manufacturers' Association is currently sponsoring work to fully characterize refractory ceramic fibre produced by their member companies. A study has been commissioned to examine potential differences between fibre types prior to conducting animal and epidemiology studies to ascertain whether refractory ceramic fibres are biologically active.

During 1985 our Glass and Ceramics Centre was involved in major programs in the field of sol-gel, electronic ceramics and engineered ceramics.

Plasma spray equipment is used to apply ceramic coating to a piston prior to testing in a diesel engine.

Engineering the structure of metals

Rapid Solidification Technology (RST) is an advanced processing technology applicable to the production of high performance metals. ORF worked on two significant RST programs during the year: RS copper-nickel alloys for marine use for Defence Research Establishment Atlantic, and RS stainless steel for general corrosion use on behalf of Sinteris Canada. In both cases, the objective was to assess the effect of RS processing on the physical and electrochemical properties of the alloys, with the ultimate goal of producing superior corrosion-resistant products for defence and civilian applications.

One of the steps required to make Rapid Solidification Technology attractive to industry is to demonstrate the feasibility of consolidating RS strips and powders. Recognizing this important need, Limpact Industries Limited engaged ORF to examine the explosive compaction of RS materials. We found that when particulate materials are subjected to shock-wave loading, accelerated particles will generate sufficient heat to cause the fusing of interparticle boundaries without creating excess heat that would degrade the RS properties of the interior of the particulate materials.

One type of coating investigated by ORF is included in a specialized class known as phosphate conversion coatings. We were engaged by Seamless Cylinders International Inc., a company that produces fire extinguisher containers by deep drawing and ironing of steel plate blanks, to investigate the causes of poor performance in existing phosphate coatings. In this type of production, satisfactory adhesion of the phosphate coating is critical to the successful retention of a lubricant for deep drawing operations.

Our research indicated that the crystal structure of the existing coating was not adequate for the retention of the lubricant. By the end of 1985, it was becoming evident that the chemistry of the coating bath could be the prime factor in influencing the morphology.

ORF has been working with Alloy Casting Industries in examining the fracture-resistance properties of steel castings at very low temperatures—such as are encountered in hostile environments in northern Canada—and their relationship to microstructures and alloy compositions.

With the objective of assisting Ontario auto parts manufacturers to become aware of new alloys and other materials available or under development, and their potential uses, the Ontario Centre for Autoparts Technology commissioned ORF to undertake studies of metals and metal matrix composites. These studies involved discussions with the major North American automobile manufacturers.

Towards better building materials

Indal Limited, manufacturer of building and industrial products, proposes to develop a proprietary product using a novel technique. To this end, ORF was engaged to carry out development on a new polymer formulation. We were able to develop a specific formulation to minimize material costs while maintaining the required mechanical properties.

Our Building Performance Centre was involved in the evaluation of a full-scale rain-screen cladding panel for Clifford Masonry. The rain-screen principle is intended to minimize rain-water penetration into the panel by equalizing the pressure of the cavity behind the exterior sheathing with the fluctuating outside wind pressure. Our evaluation reveals all the potential weaknesses of the cladding panel and permits the verification of a particular design before construction begins.

A project completed by ORF for the Canada Centre for Mineral and Energy Technology consisted of a review of methods to reduce the energy consumption in gypsum board manufacture, using information from the literature and the research departments of gypsum board companies. We concluded, first, that the area with the greatest potential to reduce energy consumption is a reduction of the water used in the process by lowering stucco water demand; and, second, that several stucco treatments should be exhaustively investigated to reduce water demand.

We have been examining the use of heart valves surfaced with metal powder for Shiley Inc. Animal studies are being conducted, with clinical trials to follow.

Environment

As public concern continues to grow over the quality of the environment, the resources of ORF have been extended significantly in many aspects of research into environmental problems. This activity, undertaken for a growing list of clients, involves the quality of air and water, with special emphasis on the environment of the workplace and the concerns relating to the management of wastes.

Working towards better air quality . . .

ORF's new Mobile Source Monitoring Laboratory (MSML) was put to use in two major programs dealing with large-scale energy from waste systems. As part of a detailed combustion-efficiency and emissions-characterization study for SNC Inc., our new MSML was driven to the Elk Falls pulp mill in British Columbia to analyze gaseous emissions from a wood-fired boiler. Subsequently, on behalf of Midwest Research Institute, of Kansas City, Missouri, two MSMLs were taken to Pittsfield, Massachusetts to participate in an extensive investigation of a plant producing energy from waste. Sophisticated systems, collecting continuous data from several gas analyzers in each MSML, provided instant information to the project team concerning combustion performance and emission of toxic pollutants.

ORF has carried out a study for the Ontario Ministry of the Environment to collect and analyze polycyclic aromatic hydrocarbon (PAH) emissions from coke ovens at three steel mills in Ontario and to evaluate short-term mutagenicity tests as potential indicators of PAH toxicity. Our results indicated an apparent correlation between mutagenicity (gene-changing) data and the benzine-soluble fraction of total particulate material collected.

ORF completed two major studies in 1985 in the field of ambient air monitoring and environmental impact.

A comprehensive air quality survey was conducted in the Sarnia area for the Lambton Industrial Society (LIS). The effectiveness of the sophisticated sulphur dioxide control strategy developed by ORF in conjunction with the LIS and the Ministry of the Environment was demonstrated by how seldom the daily sulphur dioxide criterion was exceeded throughout the year. This cooperative approach is also cost-effective for participating companies.

For the Ontario Waste Management Corporation (OWMC), ORF completed a series of comprehensive studies on the impact of a proposed integrative waste-management facility. Studies were done on the comparative air quality and atmospheric dispersion in eight candidate sites, to determine an order of preference based on air-quality factors. This analysis along with studies undertaken by others resulted in the selection of

Our new Mobile Source Monitoring Laboratory (MSML) was used to measure emission levels at two energy from waste project sites in the United States.

In the increasingly significant area of waste management, treatment of liquid and solid wastes requires intensive study, and the Ontario Research Foundation has been involved in a growing number of programs and projects.

Scientist Anne Contala monitors the performance of a smoke mask worn by Monica Szabo as part of a program for Transport Canada.

a preferred site in the township of West Lincoln. Later in the year, we began the installation of a meteorological and air-quality monitoring station at the site, which is now collecting baseline data.

. . . and a cleaner working environment

In 1985 ORF carried out two major occupational health surveys under sub-contract to the private sector to provide data for the Ontario Ministry of Labour.

For Hatch Associates Limited we measured the exposure levels of workers to total welding fume and individual fume contaminants in a variety of welding processes.

In the second survey, undertaken for Michael Holliday & Associates, testing was done in connection with wood-using plants such as sawmills, veneer mills and plants manufacturing furniture, toys and houseware products. It was revealed that in several of the operations, personal hardwood-dust exposure levels exceeded existing guidelines.

A study was conducted for Transport Canada to establish criteria for airline passenger smoke masks and to determine whether existing commercially available products met these criteria. Investigations of recent airline disasters involving on-board fires have shown that many passenger deaths were the direct or indirect result of smoke or toxic gas inhalation.

Once criteria were established and information evaluated on commercial masks, six makes out of 24 available were selected for testing. While no one mask satisfied all of the criteria, all were found to provide the wearer with some additional escape time.

New U.S. EPA regulations imposing stringent diesel emission standards for 1991 have necessitated increased efforts being made in the area of diesel emissions control. A program supported by the Ontario Ministry of Industry, Trade and Technology has resulted in our developing a diesel exhaust filtration system which was successfully applied to a Detroit Diesel 6V71 engine commonly used in North American buses. Field-testing is scheduled.

Improvement in the development of diesel filters for underground mining vehicles has been spurred by a collaborative program sponsored by the U.S. Department of the Interior Bureau of Mines, the Ontario Ministry of Labour and the Canada Centre for Mineral and Energy Technology. This program resulted in successful field-testing of filter units mounted on a load-haul-dump machine in production service in northern Ontario mines.

Alice Liebert operates our Philips Transmission Electron Microscope, capable of magnifying almost 400,000 times, which permits identification and characterization of materials samples, such as asbestos.

Improving the management of waste materials

On behalf of Energy, Mines and Resources Canada (EMR), we assessed the application of wet air oxidation technology to oil sand recovery operations in an experimental study on several process products and waste streams. Batch scale WETOX® experiments were performed on produced waters, delayed and fluid cokes, pitch and asphaltenes, demonstrating the versatility of such applications at lower cost. A modification of the reactor, designed to produce high energy output per unit reactor volume, was patented.

Another project undertaken for EMR concerned the development of a waste-treatment system for biomass or coal conversion wastewaters with the generation of a high-energy biomass. The use of wet air oxidation technology was found to be effective, though anaerobic digestion was needed to complete the degradation of the toxic effluent.

It has been noted that the extensive peat deposits of northern Ontario could form the basis of cost-effective and efficient wastewater treatment, with a high degree of treatment nutrient and coliform bacteria removal. In cooperation with Monenco, ORF made an assessment of appropriate methods to utilize the peat deposits for either seasonal or year-round operation, applicable to settled sewage, grey water and biologically treated sewage. Three potential locations in Ontario were identified for our clients, the Ministry of the Environment and the Ministry of Northern Affairs.

Because the safe destruction of polychlorinated biphenyls (PCBs) and materials contaminated with PCBs continues to be a serious problem in North America, Environment Canada engaged ORF to complete an assessment of all commercial and near-commercial technologies applicable to liquid and solid PCB wastes. In particular, detailed information was requested on mobile facilities, since these are currently favoured for use.

In a two-phase study for Environment Canada—a review of literature and a site examination to investigate the physical stability of power plant wastes—we concluded that, with few exceptions, both fly ash and flue gas desulphurization solids could be disposed of in such a way that direct site reclamation would be feasible.

The Federal Government has sponsored additional paper studies on specific wastes and hazardous materials. For Environment Canada, ORF provided a technical manual for the management of chemical wastes from laboratories.

The Canadian and Ontario Waste Materials Exchanges, operated by ORF, provide a valuable service to Canadian industry in the face of mounting environmental hazards and the economic loss to industry occasioned by the problems of liquid and solid waste disposal. The Canadian exchange is a national clearing house for industrial waste producers and users, with more than 3,700 companies currently participating. As a result of this program, more than 270,000 tonnes of waste are being re-used or recycled for other uses each year.

Products and Processes

Our research into products and processes involved a wide spectrum of activities, ranging from development of air-particulate evaluation equipment to design improvement through competitive product analysis and performance characteristics of shipment containers.

Product development; process enhancement

ORF assisted the Atmospheric Environment Service of Environment Canada in the development of a prototype instrument to measure both particulate and gaseous phase fractions of high molecular weight chlorinated organic compounds in ambient air. This instrument uses a molecular diffusion denuder prior to particulate collection by filtration. Preliminary field tests on the new instrument were completed and further tests are being conducted.

During 1985 we received a number of contracts concerning the pressing problem of nuclear decontamination. We assisted London Nuclear Inc. in pursuing process development in pressurized water decontamination and studying the mechanism of oxide film removal from stainless steel and inconel, resulting from parametric cycling. Following this cooperative research, London Nuclear won the prestigious IR-100 award for their CAN-DECON PWR Nuclear Decontamination process in September. Both ORF and AECL Chalk River were given credit for technical support.

London Nuclear moved into the application of a new chemistry for decontamination purposes and our Materials Corrosion Section has expended considerable effort to learn and apply this new technology. ORF was subsequently awarded the programs for the study of this process by London Nuclear's clients.

ORF has provided technical assistance to the True North Syndicate which is designing and building a yacht challenge for the 1987 America's Cup Races in Australia. While highly confidential, the projects have been in the areas of materials development and equipment design to advance the state of the art in racing sailboats, a field not unlike aerospace in the importance attached to weight reduction and performance improvements and for its potential to develop technology spinoffs.

Rapid development of computer-aided engineering

1985 represented the first full year of operation for our Computer-Aided Engineering, and it proved to be a year of encouraging rapid growth.

Kenhar Products Inc., manufacturers of forks for fork-lift trucks, wanted their products to match the load-carrying and design-life characteristics of a major competitive product in the world market. Since a clear understanding of the competitive product was seen to be the first step towards product improvement, a detailed finite element stress analysis was performed on this

Mary Jane Hanley sets up a prototype instrument for measuring organic compounds in ambient air. ORF assisted in the development of the new instrument for Atmospheric Environment Services.

ORF provides ongoing consulting, testing and development support on behalf of Dominion Cellulose. This company has gone into full production of a 2-ply bathroom tissue using a new process technology developed by our Dr. Geza Matolcsy. An agreement has been signed for the sale of this technology to PWA Waldhof Gmbh in Germany.

Three-dimensional images of Flyer bus underbody components for the purpose of fatigue qualification are digitized by Ed Skiba of CAE.

product; then the Kenhar product was similarly analyzed and its mechanical characteristics optimized in the course of evaluating numerous and highly subtle design changes.

Our ongoing activities on behalf of Flyer Bus Industries provided a major project in computer-aided engineering. Along with the finite element stress analysis which we performed on this client's 40-foot transit bus, we undertook an extensive experimental survey of bus routes in various cities in which the bus is intended to operate. These environmental tests permitted the derivation of meaningful design stress criteria to be utilized in conjunction with analytical stress-analysis work.

For the Defence Research Establishment Valcartier (DREV) a number of projects have been performed, primarily in the area of vulnerability assessment.

DREV has a requirement to be able to study the effect of blast over-pressure on structural walls. To this end, ORF implemented the large displacement dynamic finite element code HONDO-III on the DREV computer system and added a graphics capability to the software which permitted the plotting of displacements, stress and time histories of key indicators.

DREV also has extensive software for the evaluation of the vulnerability of military systems to attack—for example, that of ships to missile attack and of enemy aircraft to Low Level Air Defence measures. We took a solid modelling program in-house from DREV and constructed a number of solid models of aircraft for future use by the client in vulnerability studies. These included fighter, bomber and combat helicopter aircraft. The modelling included all structures, fuel, engines, weapons, control systems and crew.

New trends in packaging technology

A research program having far-reaching implications involved the performance characteristics of selected container systems used for the transport of dangerous goods. Our research established statistically that many of the containers

in current use will not meet national and international regulatory requirements. At the same time, containers which do not comply fully with legal requirements have demonstrated a successful history in practice. The implication is that regulations should be re-examined for validity on a national and international basis.

We conducted an examination of test methods used for determining performance levels—specifically catastrophic shock and testing with recommended ASTM methods.

Working in cooperation with Transport Canada and CP Rail, we conducted experiments to monitor the levels of vibration and shock experienced by cargo during a typical trans-Canada rail journey. This was accomplished by placing accelerometers and shock recorders in freight and lading. The resulting information was recorded on 21 VHS tapes, and programs are now under development to analyze these data.

Research into thin films

On behalf of the Department of Energy, Mines and Resources (CANMET), we are currently examining existing and new techniques for the physical characterization of thin film electrodes used in electrochemical devices such as fuel cells. Our studies are being basically directed towards cultivating a non-destructive technique to assess the electrode's surface texture and relate this to more intrinsic parameters. Once these tests have been developed and refined, they will be used to study the operational parameters of a complete fuel cell, with the object of providing a better means to optimize operating efficiency.

Promoting better management techniques

Our Industrial and Management Services (IMS) developed and introduced a six-session Supervisory Development Seminar series during 1985. The program was presented as a public offering in the spring and fall of the year and also delivered on a customized basis for several clients as an in-house program. Individual clients are able to select from a wide range of topics and schedule sessions to accommodate operational requirements. Further seminars on productivity and quality assurance were presented at the executive level.

IMS continued its normal consulting operations for client companies. Assignments were concerned with operational assessment, marketing studies and productivity enhancement. In addition, a special unit was organized for consultation on specific quality problems. Project work was focussed on Supplier Certification Programs and Statistical Process Control (SPC) Implementation Assistance.

Technical assistance under the National Research Council sponsored Industrial Research Assistance Program (IRAP) was provided to 700 companies on a no-charge basis by six full-time field representatives during 1985.

Mike Galda conducts a resonance search of a computer component in our packaging laboratory to determine areas susceptible to vibration damage.

Energy

During 1985 ORF continued to accelerate its research in the extraction of energy from biomass and the development of alternative fuels. An increasing number of clients, from the private sector and from government, called upon the research and testing facilities of ORF to assist them with developing and refining products and methods in the ongoing quest for more cost-efficient energy sources.

Putting new energy sources to work

Biomass fuel produced from wood and waste wood is an abundant renewable energy source. Obstacles to the widespread acceptance and use of biomass as a fuel are the absence of an efficient, clean biomass fuel burner and the lack of a cost-effective distribution network for the biomass fuel.

Canadian Solifuels Incorporated (CSI), with assistance from Ontario Research Foundation, have developed a cyclonic biomass fuel burner. The burner's clean, stable flame permits replacement of gas and oil fired burners in industrial and commercial boilers without the penalty of reduced efficiency or frequent cleaning associated with conventional biomass combustors.

The problem of distribution is being addressed by the development of a small capacity biomass powered gas turbine cogeneration system. This highly efficient and low cost system will utilize unrefined biomass fuel and produce both process heat and electricity. The electricity produced can be distributed through the already existing distribution network, rather than transporting biomass fuel to the point of use. ORF is assisting in the development of a pressurized burner for use in the cogeneration system.

Developing the Alternatives

ORF undertook a number of significant projects in 1985 involving the use of alternative fuels—propane, natural gas, methanol and ethanol—applied to both spark-ignition and compression-ignition systems.

A major project, undertaken for two government clients—the Ontario Ministry of Energy, and

Fuel pellets for consumption in a cyclonic biomass burner are discussed by Dali Bar (right) of Canadian Solifuels Inc., and Ed Tyrcz of Ontario Research Foundation.

"Successful completion of our program with ORF may result in the creation of a large number of jobs in Ontario and Canada."

Bill Jones of the Centre for Alternative Fuel Utilization test drives a Massey Ferguson tractor refitted with a fuel system using about 30 percent ethanol.

the Ministry of Transportation and Communications—resulted in the development of a heavy-duty propane engine suitable for Class 8 trucks. This engine is based on a Cummins NTC 350 diesel developed to run on 100% propane.

A Western Star truck, re-powered with the propane engine, was put into service with a large trucking company. Driving characteristics proved to be excellent and a number of advantages were noted over the engine's diesel-fuelled counterpart.

Extensive research has been devoted to the evaluation of cars fuelled with methanol and methanol-gasoline blends. Methanol-burning cars were specially adapted for the alcohol fuel and an unusual fleet-test was conducted with methanol-gasoline blends in unmodified passenger cars. This test was specifically undertaken for our client, Celanese Canada Inc. Blends containing 6% methanol and 2% co-solvent were tested, principally to assess their effectiveness as a summer-grade fuel.

On behalf of Agriculture Canada, ORF and Perkins Engines in England have conducted extensive tests on the application of biomass-derived fuels to a Massey Ferguson tractor. Experimental fuels included ethanol-diesel emulsions and ethanol-canola monoester blends. Satisfactory substitution levels were achieved with the monoester fuel blended with diesel.

In parallel with these studies, ORF developed a retrofit fuel system which permitted the fumigation of ethanol in a Perkins diesel engine. By using an electronic controller to inject the correct amount of alcohol automatically, under varying operating conditions, satisfactory engine performance was maintained. A farm tractor refitted with a fuel system using about 30% ethanol is now ready for extensive field trials.

Resources

The efficient use of our country's natural resources, with maximum benefit to the nation as a whole and minimum impact on the environment, remains a high priority with both government clients and those from the private sector, particularly in the area of mineral recovery.

Fuels from renewable resources

A number of significant studies on the production of useful fuels from renewable resources were conducted by ORF in 1985. For Energy, Mines and Resources, we launched a program to produce water-resistant densified biomass fuel pellets from comminuted jack pine wood under 4,000 psi pressures. This involved the assessing of variation in the density and strength of pellets with changing press temperatures, wood size, moisture content and additives.

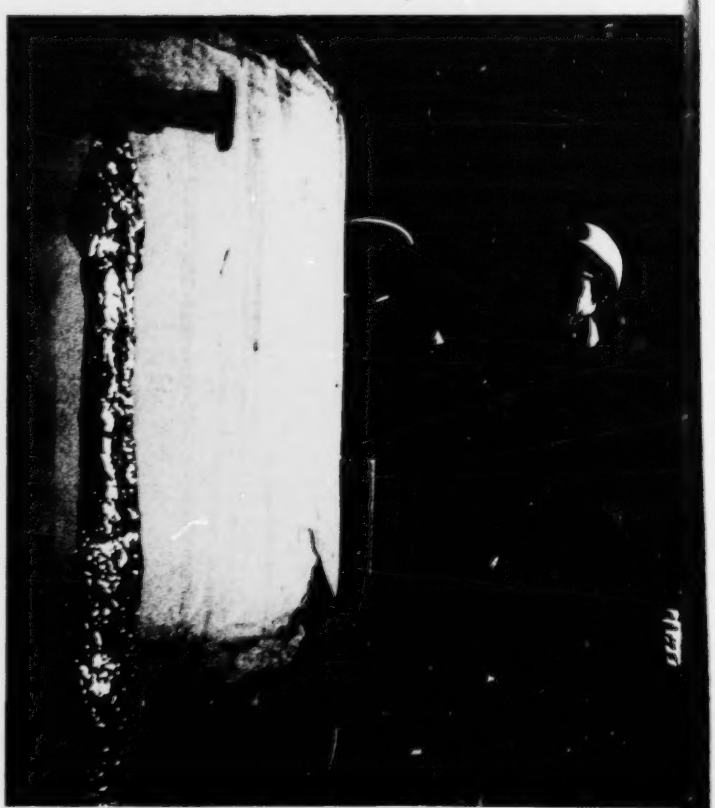
The National Research Council continued to support the application of a newly developed fermenter-purifier system for the production of fuel alcohols. In this research, our major emphasis throughout the year was on the development of butanol-acetone-ethanol fermentation using a specific microbiological culture with effective separation and collection of alcohols. We then developed a computer model to analyze the total economics and cost sensitivity of major variables in the use of fuels from the butanol process in transportation and farm machinery.

In our research on the potential of Ontario peat deposits as a source of future fuel, we were concerned with the problem of developing the appropriate technology for dewatering and processing the peat. For Environment Canada, we completed an investigation of specific methodology to treat wastewaters from thermal processing and dewatering of fuel-grade peat. We were able to achieve the successful removal of colour, biochemical and chemical oxidation demand through a thermophilic anaerobic digestion of peat wastewaters using an expanded activated carbon bed, with a personal computer acting as a control system.

Value from waste

On behalf of CANMET, we engaged in major projects directed towards studying the behaviour of glassy by-products such as fly ash, blast furnace slag and non-ferrous slag, and silica fume in concrete. For the Electric Power Research Institute of Palo Alto, California, we investigated the direct acid leaching of fly ash to optimize the recovery of metal values and to develop filler applications for the solid residues. A laboratory study was undertaken to assess the viability of using ash as a source of filler materials for plastics. Also, on behalf of our client, Associated R & D Marketing Inc., we conducted a study on the recovery of activated carbon values from ash.

Autoclave pressure is monitored by Don Hebert during a project to recover vanadium from fly ash.



"The ORF staff expended extraordinary effort to help us meet the tight deadlines imposed by our clients."

Fly ash, currently treated as a waste product, contains sufficient vanadium and carbon to make their recovery worthwhile. As a result of extensive bench-scale testing at ORF, the recovery of both vanadium and carbon from fly ash in Canadian oil sands operations is being evaluated.

Processing the earth's riches

Canadian coal was the subject of various projects conducted in our Pilot Plant during 1985.

In a CANMET program, continuing from 1984, we obtained good results with western Canadian coals in producing liquid and gaseous hydrocarbons using flash hydropyrolysis. Experience gained with western coals formed the basis for a new project dealing with eastern coals in 1986.

Our Pilot Plant staff also treated micro-agglomerated samples of both bituminous and sub-bituminous coal for the Alberta Ministry of Energy and Natural Resources. The objective of the program was to dry and carbonize the samples at low temperature. Due to the wetness of the coals, it was necessary to include an extra drying stage rather than operate a single-stage drying-carbonizing unit.

Howden Canada has purchased the patents to plasma arc technology developed at the University of Toronto. With ORF's assistance, Howden constructed a 1,000-kilowatt Plasma Extended Arc Reactor in our Pilot Plant which will initially be used to recover metal values from metallurgical industry process wastes.

In the area of non-metallic minerals, a test program was conducted on behalf of Société Nationale de l'Amiante (SNA). The program involved comparing the quality of their traditional asbestos products to their newly prepared chrysophosphate fibre products. It is anticipated by SNA that chrysophosphate has a good potential for asbestos markets in the future.

On behalf of CANMET, a project was undertaken to develop an energy-efficient wet-milling method for extracting asbestos fibre from tailing materials. This project included the design and fabrication of novel unit process equipment.

The Alaskan Asbestos project, which was initiated in 1978, was completed in 1985. The 1985 phase focussed primarily on completing both the large and small core processing programs and preparing fibre products that met commercial specifications. A brief wet-milling program was also initiated.

Financial Statements

Consolidated Balance Sheet

as at December 31, 1985 ($000's)

	1985	1984
Assets		
Current assets		
Cash	$ 17	$ –
Short-term deposits	552	1,001
Accounts receivable	4,966	4,626
Prepaid expenses	359	225
	5,894	5,852
Investments (note 2)	1,790	1,362
Fixed assets (note 3)	14,099	14,377
	$21,783	$21,591
Liabilities		
Current liabilities		
Bank indebtedness	$ –	$ 133
Accounts payable and accrued liabilities	1,989	2,107
Amounts received in advance for research and other projects	1,147	310
	3,136	2,550
Capital		
Capital contributions	3,363	3,363
Fixed asset contributions	5,990	6,405
Appropriated surplus (note 4)	9,250	9,250
Unappropriated surplus	44	23
	18,647	19,041
	$21,783	$21,591

Approved on Behalf of the Board of Governors

A. J. Harris

Dr. D. A. Chisholm

Auditors' Report

To the Board of Governors of Ontario Research Foundation

We have examined the consolidated balance sheet of Ontario Research Foundation as at December 31, 1985 and the consolidated statements of income and unappropriated surplus, fixed asset contributions and changes in financial position for the year then ended. Our examination was made in accordance with generally accepted auditing standards and accordingly included such tests and other procedures as we considered necessary in the circumstances.

In our opinion these consolidated financial statements present fairly the financial position of Ontario Research Foundation as at December 31, 1985 and the results of its operations and the changes in its financial position for the year then ended in accordance with generally accepted accounting principles applied on a basis consistent with that of the preceding year.

Toronto, Canada, January 31, 1986

Chartered Accountants

Consolidated Statement of Income and Unappropriated Surplus

for the year ended December 31, 1985 ($000's)

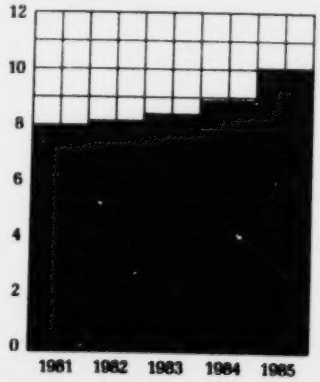
	1985	1984
Revenue		
Professional services	$18,895	$16,327
Performance grant from the Province of Ontario (note 5)	3,900	3,750
Investment income	534	346
Royalties	940	469
Other	32	57
	24,301	20,949
Expense		
Salaries and benefits	12,584	12,365
Other costs of research	9,671	6,973
General	2,025	1,597
	24,280	20,935
Income for the year	21	14
Unappropriated surplus, beginning of year	23	9
Unappropriated surplus, end of year	$ 44	$ 23

Consolidated Statement of Fixed Asset Contributions

for the year ended December 31, 1985 ($000's)

	1985	1984
Fixed asset contributions, beginning of year	$ 6,405	$ 6,229
Fixed asset contributions received from the Province of Ontario (note 5)	676	926
	7,081	7,155
Transfer to income	1,091	750
Fixed asset contributions, end of year	$ 5,990	$ 6,405

Industrial Revenue Growth
$ millions



Consolidated Statement of Changes in Financial Position

for the year ended December 31, 1985 ($000's)

	1985	1984
Operating activities		
Earnings		
Income for the year	$ 21	$ 14
Charges (credits) to income not involving cash		
Depreciation	2,732	1,802
Transfer from fixed asset contributions	(1,091)	(750)
Gain on sale of investments	(287)	(71)
	1,375	995
Net decrease (increase) in non-cash current assets		
Accounts receivable	(340)	(1,003)
Prepaid expenses	(134)	58
Net increase (decrease) in non-cash current liabilities		
Accounts payable and accrued liabilities	(118)	969
Amounts received in advance for research and other projects	837	85
	1,620	1,104
Financing activities		
Fixed asset contributions (note 5)	676	926
Investing activities		
Purchase of investments (net)	(141)	(77)
Cost of construction	(80)	(158)
Acquisition of apparatus and instruments (net)	(1,777)	(1,691)
Acquisition of other fixed assets (net)	(597)	(151)
	(2,595)	(2,077)
Increase (decrease) in cash and equivalents (short-term deposits less bank indebtedness) during the year	(299)	(47)
Cash and equivalents, beginning of year	868	915
Cash and equivalents, end of year	$ 569	$ 868

Notes to Consolidated Financial Statements

December 31, 1985

1. SUMMARY OF SIGNIFICANT ACCOUNTING POLICIES

A. Principles of Consolidation

These consolidated financial statements include the accounts of Ontario Research Foundation and its wholly-owned subsidiary, Ordco Technology Limited.

B. Fixed Assets and Depreciation

Fixed assets are stated at cost. Depreciation is provided on a straight-line basis at the following annual rates:

Buildings	3⅓% and 5%
Equipment	6⅔%, 10%, 20% and 33⅓%
Automotive equipment	33⅓%

In 1985, the depreciation rate of some equipment has been increased from 15% to 20% and other equipment from 20% to 33⅓% as a result of adjustments to their estimated useful lives.

C. Capital Contributions

Capital contributions comprise the original capital sums donated by the Province of Ontario and industry, the income from which is being used to assist in meeting annual expenses in accordance with the terms of the contributions.

D. Method of Computing Revenue

Professional Services Revenue

Professional services revenue is recognized on the basis of the percentage of completion of the work at estimated fees earned or at per diem billing rates depending upon the contractual arrangements.

Fixed Asset Contributions

Fixed asset contributions received from the Province of Ontario and industry are included in capital and are transferred to income over the useful lives of the related assets.

Gains on Sale of Investments

Net gains realized on the sale of investments are reflected as revenue in the statement of income.

2. INVESTMENTS

	1985	1984
Short-term investments, at cost	$ 875	$ 416
Bonds, at amortized cost		
Government, direct and guaranteed	399	199
Industrial and other	—	23
Common stocks, at cost	516	724
	$1,790	$1,362
Quoted market value	$2,366	$1,993

3. FIXED ASSETS

	1985			1984
	Cost	Accumulated Depreciation	Net	Net
Land	$ 597	$ —	$ 597	$ 597
Buildings	12,547	5,409	7,138	7,551
Equipment	18,714	12,388	6,326	6,197
Automotive equipment	118	80	38	32
	$31,976	$17,877	$14,099	$14,377

4. APPROPRIATED SURPLUS

Surplus has been appropriated for the replacement and expansion of the physical plant.

5. GRANTS FROM THE PROVINCE OF ONTARIO

In 1985, Ontario Research Foundation received from the Province of Ontario grants totalling $4,576,000 of which $3,900,000 has been allocated to income and $676,000 to fixed asset contributions.

6. CONTINGENT LIABILITIES

A. A claim in the amount of $50,000,000 has been made against Ontario Research Foundation and eight other defendants alleging unlawful conspiracy among the defendants.

B. A claim for damages alleging negligence in approving the safe use of urea formaldehyde foam insulation has been made against Ontario Research Foundation and thirteen other defendants.

Ontario Research Foundation is disputing these claims and has instructed its solicitors to defend its position. While the results of litigation and claims cannot be predicted with certainty, based on advice of counsel, management believes that the final outcome of these matters will not have a materially adverse effect on the consolidated financial position.

7. COMPARATIVE FIGURES

Certain figures for 1984 have been reclassified for comparative purposes to correspond with the classification adopted in 1985.

Scientific and Technical Papers 1985

1222 O. Caporaletti M. R. Westcott
Fabrication of CdTe thin films by electron-beam evaporation. Can. J. Phys. 63, 798-800 (1985)

1223 A. Lawson H. C. Vergeer W. Drummond J. P. Mogan E. D. Dainty
Performance of a Ceramic Diesel Particulate Trap Over Typical Mining Duty Cycles Using Fuel Additives. Proceedings, SAE International Congress & Exposition, Detroit, Michigan. Paper No. 850150. February 25–March 1, 1985. (Reprinted from P-158–Diesel Particulate Control.)

1224 J. P. Mogan E. D. Dainty H. C. Vergeer A. Lawson K. C. Westaway J. K. Weglo L. R. Thomas
Investigation of the CTO Emission Control System Applied to Heavy-Duty Diesel Engines used in Underground Mining Equipment. Proceedings, SAE International Congress & Exposition, Detroit, Michigan. Paper No. 850151. February 25–March 1, 1985.

1225 H. C. Vergeer S. T. Gulati J. P. Mogan E. D. Dainty
Electrical Regeneration of Ceramic Wall-Flow Diesel Filters for Underground Mining Applications. Proceedings, SAE International Congress & Exposition, Detroit, Michigan. Paper No. 850152. February 25–March 1, 1985. (Reprinted from P-158–Diesel Particulate Control.)

1228 P. C. Nautiyal W. A. Goetz L. Hoffman-Goetz
Cold Start Wear Performance in Methanol and Gasoline Engines. Proceedings, SAE International Congress & Exposition, Detroit, Michigan. Paper No. 850215. February 25–March 1, 1985.

1227 C. A. McGugan P. F. Edwards M. Riley
Performance Testing of Residential Heat Recovery Ventilators. Proceedings, Conference on Conservation in Buildings: Northwest Perspective, Montana College of Mineral Science Technology Campus, Butte, Montana. Paper No. 1-83, May 19-22, 1985.

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Your industrial waste–garbage or gold? Process Industries Canada, April/May, 1985, pp. 12, 13, 15, 17.

1229 J. D. Sheppard H. L. Robey M. P. McKim
The Effects of Temperature on the Partial Wet Oxidation of Peat. The Canadian Journal of Chemical Engineering, Volume 63, Number 4, 1985, pp. 645-649.

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Measurement and Interpretation of Asbestos Fibre Concentrations in Ambient Air. Proceedings of the 5th AIA Colloquium, Johannesburg, S.A., October 1984.

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New Methods for Monitoring of Asbestos Fibre Concentrations in Workplaces and Ambient Atmospheres. Proceedings of the 5th AIA Colloquium, Johannesburg S.A., October 1984.

1232 R. K. Dwivedi G. Gowda
Thermal stability of aluminium oxides prepared from gel. Journal of Materials Science Letters 4 (1985) 331-334.

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Synthesis of an Olefinic Sterol Derivative for use as a Membrane Probe. J. Chem. Soc. Chem. Commun. 1985.

1234 K. L. Yan B. G. Sellars J. Lo S. Johar M. K. Murthy
Storage of Hydrogen by High Pressure Microencapsulation in Glass. Int. J. Hydrogen Energy. Vol. 10, No. 7/8, pp. 517-522, 1985.

1235 H. Shimizu J. Leidner
Porous Materials for Medical Devices. Medical Device & Diagnostic Industry, February, 1985.

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Instrumented Impact Testing of Steel Plate. Journal of Testing and Evaluation, March, 1985.

1237 M. van Roode R. T. Hemmings
Development of a Unified Theory for Predicting the Behaviour of Glassy Waste Products (Fly Ash, Fumed Silica and Slags) in Concrete and to Develop New Compositions of Concrete for Offshore Applications. CANMET Contract Report No. ISQ83-00162, July 1985.

1238 G. Gowda
Synopsis on: Chemical processing in ceramic development by J. L. Hopkins, CIM Bulletin, August 1985.

1239 C. T. Harrison
Evaluation of Single Ply Roofing Membranes–The Canadian Experience. Proceedings: Third CSCE Conference on Building Science and Technology, Toronto, Ontario, November 14 & 15, 1985.

Some of Our 1985 Clients

ABC Plastic Moulding
Abitibi-Price Inc.
Alberta Energy
Celanese Canada Inc.
Agriculture Canada
SNC Group
Midwest Research Institute
Lambton Industrial Society
Transport Canada
U.S. Bureau of Mines
Energy Mines and Resources Canada
Ontario Ministry of Environment
National Research Council
BM Hi-Tech
Defence Research Establishment Atlantic
Sinteris Canada
Limpact Industries
Seamless Cylinders International
Alloy Castings Industries
London Nuclear Ltd.
Indal Limited
Clifford Masonry
Dominion Cellulose
Kenhar Products
Howden Group Canada
Defence Research Establishment Valcartier
Michael Holliday and Associates
Atlantic Packaging Company
Ben David Dyeing & Finishing Ltd.
Blue Bird Bakery Ltd.
Canada Metal Co.
Canadian Gypsum Co. Ltd.
Champion Road Machinery Ltd.
City of Medicine Hat
CMS Rotordisc
Dawn Carpets Ltd.
Designed Precision Castings Ltd.
Donlee Precision
DiMarcantonio Industries
EID Systems Inc.
The Electrofuel Mfg. Co.
Ellis-Don Ltd.
ESSO Chemical Canada
Fabra-Wall
Flags Unlimited Inc.
Flyer Industries Ltd.
Fox Fluid Power Inc.
Garfields' Ltd.
General Foods
Gordon Yarns Dyers Ltd.
H. H. Brown Shoe Company
Hawk's Welding and Wire
Hart Chemical Co.
IIL Limited
International Drilling Fluids
ITT Grinnell
Jarvis Clark Company
Johnson Rubber Co.
Keeprite Inc.
Kettle Creek Canvas Co.
Korea Trade Centre
Lakefield Research
Mansonville Plastics Ltd.
Marimac
Meditech Canada
National Sewer Pipe
New Tech Chemicals
North York Hydro
Olin Research Centre
Ontario Centre for Auto Parts Technology
Ontario Waste Management Corporation
Parry Sound District Hospital
Peel Board of Education
Rayshield Ltd.
Reach Plastics & Chemicals Inc.
Samuel Strapping Systems Ltd.
Saskatchewan Power Co.
Shamrock Chemicals Ltd.
VIA Rail Inc.
Waltech Bathware
Warrington Inc.
Western Research
Ziebart Rustproofing Ltd.

Assistance to Outside Organizations

More than 50 staff members contributed to the overall advancement of technology through service on various boards and committees during 1985.

Air Pollution Control Association
American Society for Testing and Materials
Associate Committee on the National Fire Code
Association of Official Analytical Chemists
Association of Provincial Research Organizations
Biological System of Mineral Leaching and Metal Recovery Network (BIOMINET)
Canadian Ceramic Society
Canadian General Standards Board
Canadian Institute of Mining and Metallurgy
Canadian Journal of Fisheries and Aquatic Sciences
Canadian Manufacturers' Association
Canadian Nuclear Society
Canadian Oxygenated Fuels Association
Canadian Research Management Association
Canadian Standards Association
Environment Canada
Health and Welfare Canada
Institute of Textile Science
International Commission on Glass
International Society for Standardization
International Society for Industrial and Hazardous Waste
McMaster University
Mohawk College
National Association of Corrosion Engineers
National Research Council of Canada
New Mexico Institute of Mining and Metallurgy
Organization for Economic Cooperation and Development
Packaging Association of Canada
Réunion Internationale des Laboratoires d'Essais et de Recherches sur les Matériaux et les Constructions (RILEM)
Sheridan College of Applied Arts and Technology
Sheridan Park Association
Society of Mining Engineers
Society of Packaging and Handling Engineers
Source Evaluation Society
Standards Council of Canada
Technical Association of the Pulp and Paper Industry
Underwriters' Laboratories of Canada

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